

Log 2435



# National Transportation Safety Board

Washington, D.C. 20594  
Safety Recommendation

Date: October 4, 1993

In reply refer to: A-93-123 and -124

Honorable David R. Hinson  
Administrator  
Federal Aviation Administration  
Washington, D.C. 20591

On June 15, 1993, United Airlines flight 940, a Boeing Model 767-322ER, N651UA, departed the right side of Runway 25R while landing at Frankfurt International Airport in Germany. The pilots had briefed for a Category III landing with the use of three autopilots in the autoland mode. According to pilot statements and data retrieved from the digital flight data recorder (DFDR), about 525 feet above the ground, the pilot used the control wheel autopilot disconnect button and continued an uneventful approach. As the nose landing gear was about to touch down, the rudder made an uncommanded movement, 16-17° to the right. The airplane crossed the right edge of the runway at about 130 knots and began to skid. The copilot assisted the pilot in pushing the rudder pedals and deflected the rudder back to the left. The ground track curved left, and the airplane missed another airplane by less than 100 yards as it returned to the runway. Once on the runway, the pilot reported that he regained "soft normal" rudder pedals after pressing the autopilot disconnect button twice. According to the DFDR, the pilot disconnected the autopilot on final approach and the recorded "on/off" state variable remained "off" thereafter. A minor passenger injury was attributed to an umbrella that fell from an overhead compartment; the airplane required new tires and a precautionary change of the left engine.

The Luftfahrt Bundesamt-Flugunfalluntersuchungsstelle (LBA-FUS), the German aircraft accident investigation authority, is conducting an investigation of this incident under the provisions of Annex 13 of the Convention on International Civil Aviation. The Safety Board is participating in the LBA-FUS investigation with the technical assistance of United Airlines, Boeing, and Collins Avionics. Ground inspections, ground testing, and an instrumented flight test were performed. Hydraulic and electrical components were removed for further examination and testing. However, the tests did not identify problems in the mechanical portions of the rudder system that could have caused the incident.

During ground tests of the United Airlines airplane in Germany, an anomaly was seen that was not related to the rudder system. The heading command digits in the autopilot mode

control panel (MCP) were observed to rotate without pilot input. When the digits again began an uncommanded change during a flight test, the airplane began a turn in response to the change. The MCP was removed and tested with automated test equipment (ATE) at a Collins Service Center. The window displays performed normally at the service center and passed the ATE tests.

United Airlines maintenance records show that the uncommanded heading window changes observed during the investigation were not isolated incidents. Some uncommanded changes on other aircraft have occurred immediately after the heading was entered by the pilot, and others have occurred intermittently during flight. The United Airlines records also showed that the MCP involved in the United Airlines Frankfurt incident had previously been removed on October 11, 1992, for an "erratic" heading window display. Following replacement of some subcomponents, the MCP was tested and returned to service.

The airplane and pilot from the Frankfurt incident traveled to Boeing to test rudder pedal resistance forces with the autopilot servos engaged. The test results indicated that the pilots had overcome pedal resistance equivalent to one engaged autopilot servo. The Safety Board is working with Boeing and Collins Avionics to analyze test results and other data.

Airline and Boeing records show that previous unexplained rudder incidents have also occurred. American Airlines 767-223, N303AA, had an unexplained landing incident on June 3, 1992. The pilots of N303AA reported that the rudder pedals were locked and would not move but that after the nose wheel strut compressed, the rudders moved normally. The airplane was removed from service for several days to completely inspect the landing gear and flight control systems, as well as to perform autopilot system tests, but the causes of the earlier rudder incidents have not been identified. After extensive testing, American Airlines engineering monitored the autopilot in N303AA for a year after the incident, and the anomaly did not recur.

Certification regulations require that pilots be provided with a positive means of disconnecting the autopilot. The Boeing 757/767 MCP is located on the cockpit glareshield and has a disengage bar that separates power from the autopilot servos at electrical relays. Control wheel disengage buttons use logic to remove ground paths from the same relays, but power remains available for reengagement if the logic state changes. Therefore, the control wheel buttons do not provide the positive disconnection provided by the disengage bar. The Safety Board believes that flightcrews should have the MCP disengage bar in the "off" position when the autopilots are not in active use. This action could prevent uncommanded autopilot actions that require pilot recognition and response during critical time periods, such as takeoff and landing.

The Safety Board also has become aware of uncommanded autopilot actions in other Boeing 757 and 767 airplanes. For example, United Airlines maintenance records show 29 Boeing 757/767 incidents of uncommanded autopilot engagements, disengagements, mode changes, or MCP window display changes. The United Airlines records list 757/767 MCP errors such as "CENTER CWS ENGAGES INTERMITTENTLY BY ITSELF WHEN IN

MANUAL MODE," "REVERTS TO LNAV INTERMITTENTLY," "GOES INTO VERTICAL SPEED BY ITSELF," and "A/C DESCENDED THRU SELECTED ALT ON MCP, ALSO IN FLCH MODE." The Safety Board is concerned that uncommanded altitude and heading changes may occur without pilot input, thus creating the potential for conflict with other aircraft or terrain.

Pilots are required to monitor their instruments during use of the autopilot, and United pilots appropriately responded to the 29 listed incidents. However, accidents and incidents have occurred when pilots have not recognized unanticipated autopilot actions. On December 29, 1972, an inadvertent autopilot disconnection led to the destruction of Eastern Airlines flight 401,<sup>1</sup> a Lockheed L-1011 that crashed in the Florida Everglades. Also, the Safety Board is aware of at least three Boeing 747 airplanes that have experienced in-flight upsets in cruise flight that are believed to have been initiated by discrepant roll computers. In one upset, on December 12, 1991, an Evergreen Airlines Boeing 747 rolled to a bank angle of more than 90°, approached supersonic speeds, and lost approximately 10,000 feet of altitude before recovery could be completed. The airplane sustained structural damage to wing skins, flaps, and the right horizontal stabilizer before landing.

Pilots communicate with the Collins autopilots installed in Boeing 757/767 airplanes through the MCP. The MCP is common to the Boeing 757 and 767. Pilots use lighted pushbuttons on the MCP, called switchlights, to engage each of the three autopilots and select autopilot operating modes. Boeing and Collins have recognized MCP switchlight quality control problems and implemented a corrective action plan. Boeing issued Operations Manual Bulletin (OMB) 93-1, dated May 14, 1993, "to advise flightcrews that uncommanded autopilot engagement or Autopilot Flight Director System mode changes may occur" because faulty MCP pushbutton switches could cause problems at any time or altitude except when multiple autopilots are engaged for approach. Operators are not obligated to inform pilots of OMB information, and the applicable MCP serial numbers did not include the serial number of the United airplane involved in the Frankfurt incident. Autopilots manufactured by Honeywell and installed in certain Boeing 737 airplanes have also had "nonselected changes" that have resulted in operational corrective action. (Reference Airworthiness Directive 88-NM-115-AD)

Boeing and Collins have instituted a fleet-wide campaign to replace all affected switchlights per Collins Component Service Bulletins (SBs) MCP-701-22-19 and MCP-704-22-10, dated April 23, 1993; and MCP-701-22-18 and MCP-704-22-09, dated April 2, 1993. Boeing has reported that approximately 80 percent of the fleet has already had the SBs incorporated and that completion is expected in 1993. Since operators are not required to comply with SBs, the Safety Board is monitoring the progress of the replacement program.

Autopilot discrepancies have been identified in groups, such as the MCP display window group and the switchlight group. Not all of the anomalous operations noted in the maintenance records can be attributed to these discrepancies and some remain unexplained.

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<sup>1</sup> See NTSB AAR-73-14

The Safety Board notes that the existing B-757/767 airplanes are capable of operating with multiple autopilot redundancy in the approach mode and that due to the unexplained nature of the incidents, use of the redundant levels would be appropriate. The Safety Board has found that none of the incidents occurred with multiple autopilots engaged. With more than one autopilot engaged, comparative logic can alert pilots to an autopilot anomaly or disconnect the autoflight system.

Rotation of MCP control knobs is interpreted by a processor to set the window display digits for selection of heading, altitude, speed, and other information. The window displays are common to all three autopilots. Nonetheless, the Safety Board believes that if an autopilot approach is flown, pilots should be encouraged to engage more than one autopilot in order to minimize the potential effects of a single autopilot malfunction. Moreover, until a permanent resolution to the display window problem is identified, implemented, and verified, the Safety Board believes that pilot monitoring of the 757 and 767 airplane heading and altitude, as presented by the MCP display windows, must be emphasized.

The Safety Board received an operator report that similar MCP window display changes had been observed in the Boeing 747-400. Boeing and Collins personnel associated with the investigation noted that despite differences, 747-400 MCP components were similar to those in the 757/767 MCP. Similarities were also noted with the Fokker Aircraft Model 100 MCP. The Safety Board believes that the FAA should determine whether 757/767 corrective actions should also apply to other models.

Therefore, the National Transportation Safety Board recommends that the Federal Aviation Administration:

Require that the Boeing Company issue a temporary Airplane Flight Manual Supplement to ensure that pilots of Boeing 757 and 767 airplanes are aware that autopilots on these airplanes have engaged, disengaged, and changed modes and mode control panel (MCP) display window settings without pilot input. Inform pilots of the circumstances and pilot actions taken during previous high rudder force anomalies. Until positive corrective actions are identified, require interim operating procedures to specify that the MCP disengage bar be placed in the "off" position when the autopilot is not actively in use and that autopilot approaches be flown with more than one autopilot engaged, when feasible. Emphasize the importance of monitoring heading and altitude, as presented by MCP display windows. (Class II, Priority Action) (A-93-123)

Require Boeing and Collins to develop corrective action for the uncommanded movements and errors seen in Boeing 757/767 mode control panel displays and switching functions. Issue an airworthiness directive (AD) to implement the necessary changes. Determine the applicability of the AD to other aircraft, such as the Boeing 747-400 and Fokker Model 100, which use similar autopilot

components or have experienced similar operational difficulties. (Class II, Priority Action) (A-93-124)

Chairman VOGT, Vice Chairman COUGHLIN, and Members LAUBER, HART, and HAMMERSCHMIDT concurred in these recommendations.

A handwritten signature in black ink, appearing to read 'C. W. Vogt', written in a cursive style.

By: Carl W. Vogt  
Chairman